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Upgrading the car fleet: evidence from an Italian scrappage scheme*

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Abstract

Car scrappage schemes are generally introduced to upgrade the car fleet to reduce environmental pressures arising from private transportation. The effectiveness of these schemes has been often questioned. The aim of this paper is to quantify the impact of an Italian car scrappage scheme on the rate of deregistration of old cars. The empirical evaluation of the policy is made possible by a discontinuity in the age of cars that could be subject to the support scheme. Results, based on detailed information on the car fleet and the deregistration of cars in the Italian market, suggest a very large impact of the scheme.

Keywords: Car scrappage schemes, Regression Discontinuity Design

JEL: H23, R48

Highlights:

- Evaluate the effectiveness of a car scrappage scheme for Italy
- Exploit the discontinuity in the age of cars to identify the effect
- The car scrappage scheme was very effective

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1. Introduction

Public policy schemes aimed at stimulating the renewal of the car fleet (e.g. scrappage schemes) are generally motivated by environmental concerns about toxic pollution and GHG emissions of driving cars. According to Air Emissions Account (Eurostat, EU28, year 2016), private transportation contributes to as much as 11% of total greenhouse gas emissions and ozone precursors emissions. In this framework, the set of public subsidies offered by scrappage schemes may be seen as Pigouvian subsidies aimed at reducing negative environmental externalities. For countries where the car production is primarily domestic, however, these schemes have been often used as a way to help domestic sectors in situations characterized by stagnant demand (Aldred and Tepe, 2011).

A number of analyses evaluated the effectiveness of car scrappage schemes. Grigolon et al., (2016) use a difference-in-differences approach and find that the scrapping schemes contributed to stabilizing total car sales in Europe during the financial crisis of 2009, by preventing a total car sales reduction of about 30% and contributing to reducing polluting emissions. However, Van Wee et al. (2011) suggest that environmental gains of scrappage schemes are generally small, and the cost effectiveness of these improvements is poor.

In this paper we evaluate the effect of a scrappage scheme introduced by the Italian government in February 2009 on the number of deregistered and new cars.

2. The scheme

The car scrappage scheme introduced in February 2009 by the Italian government (L. 33/09), with no limit for the public budget, awarded a subsidy of 1.500 euros for buying a new vehicle after scrapping a passenger vehicle registered before the 1st January 2000 and compliant with EURO2 or earlier emission standard. The subsidy was further increased if the new car was fuelled with LPG. The program was active from 7th February 2009 until 31st December 2009. The strength of the scheme was augmented by the coupled incentives offered by all car makers to the buyers of a new car. Overall, about 1 million vehicles were purchased taking advantage of the scheme.

The main econometric issue is the absence of a clear counterfactual as the scheme covered the entire Italian territory, with no regional differences in its implementation. Moreover, 2009 is the year in which the financial crisis resulted in a reduction in Italian nominal GDP of 3.5%, which is likely to have influenced car deregistration and purchase decisions in a substantial and generalised way.

3. Regression discontinuity design

One possibility to obtain a proper counterfactual is to exploit the discontinuity of the scheme which covers only cars registered before the 31st December 2000. It is possible to assume that, while owners of cars not eligible for the subsidy (car with less than 10 years) are not affected by the scrappage scheme in their choice to scrap the car or not, owners of cars older than 10 years will respond to the policy. Figure 1 and Figure 2 report the age distribution of deregistered cars by region for 2008 (prior to the scrappage scheme), 2009 (year of the scheme) respectively, with a quadratic fit.[1] A clear evidence of a discontinuity at age 10 is visible in 2009 (the year of the scheme), while no discontinuity is observed for 2008.

[Figure 1 and Figure 2 here]

To estimate the significance and magnitude of this discontinuity we apply a regression discontinuity design (RDD henceforth). We estimate the following equation:

$$y_{i,a} = \gamma Older10_{i,a} + \beta_1 Age_{i,a} + \beta_2 Age_{i,a}^2 + \beta_3 Age_{i,a} \times Older10_{i,a} +$$

$$+\beta_4 Age_{i,a}^2 \times Older10_{i,a} + \mu_i + \varepsilon_{i,a} \quad (1)$$

where $y_{i,a}$ is the logarithm of deregistered cars in region *i* with age *a*, $Older10_{i,a}$ is a dummy variable that takes the value of 1 when age is 10 or greater, $Age_{i,a}$ is age in years, $Age_{i,a}^2$ is its squared and μ_i is the region fixed effect. This specification assumes that the distribution of deregistered cars by age can be described by a quadratic fit and that the fit can be different for cars older than 10 years and cars younger than 10 years. The coefficient γ measures the discontinuity between the two quadratic fits and can be

[1] Data on deregistrations from the car registry broken down by age of the car and region (NUTS) for years 2005-2009 are provided by the Automobile Club Italiano (ACI) http://www.aci.it/laci/studi-e-ricerche/dati-e-statistiche/autoritratto.html.

interpreted as the local average treatment effect (LATE, Angrist and Pischke, 2009) of the scrappage scheme. The unit of observation is the region-age pair. OLS regressions are weighted by total deregistered cars in the region.

[Table 1 and Figure 3 here]

Results for years 2008 and 2009 are reported in Table 1 and Figure 3. As expected, no significant discontinuity is found for the two years in which no scrappage scheme was in place, while a large and statistically significant discontinuity is found in year 2009. We estimate that the scrappage scheme induced an increase of about 172 log points (458%) in the deregistration of cars older than 10 years with respect to cars younger than 10 years around the threshold. Results remain robust when we allow the quadratic fit common to vary across NUTS2 regions (second panel of Table 1).

[Table 2 here]

In Table 2 we perform a placebo test by arbitrarily changing the age thresholds. Results for thresholds set at 8 and 9 years show small and not significant (10% significance for age 8) discontinuities while the discontinuity found for age 10 was much larger in magnitude and very strong in terms of statistical significance.

4. Difference-in-differences

The RDD approach is useful to identify causal links but cannot provide a general quantification of the treatment effect beyond the neighbourhoods of the threshold as it can only be interpreted as LATE.

An alternative way to exploit the discontinuity at age 10 of the scheme is to use past trends of deregistrations by age (below 10 years) and region as counterfactual. We estimate the following equation for a panel of region-age observations over the period 2005-2009:

$$y_{i,t,a} = \gamma Older10_{i,a} \times D^{t=2009} + \eta_a Trend_t + \mu_{i,a} + \phi_{i,t} + \varepsilon_{i,t,a} \qquad (2)$$

where $y_{i,t,a}$ is the logarithm of deregistered cars in year t and region i, with age a, $Older10_{i,a}$ is a time-invariant dummy variable that takes the value of 1 when age is 10 or greater, $\eta_a Trend_t$ are age-specific linear trends, $\mu_{i,a}$ are age-region fixed effects (that absorb the treatment dummy $Older10_{i,a}$) to account for age-specific region-level shocks and $\phi_{i,t}$ are region-year dummies to account for region-specific time shocks.

The coefficient γ estimates the deviation of the deregistration rate for cars older than 10 years in the year 2009 compared to the counterfactual. Even though this estimate may be biased (e.g. the series of deregistration for old car experienced a break in 2009 that is not linked to the scrappage scheme), this is not confined to be valid for cohorts of cars close to 10 years but refers to all cars older than 10 years.

[Table 3 here]

Results are reported in Table 3. Evidence suggests an effect of about 59.6 log points (81.5%, column 1), that is much smaller than the RDD-based LATE estimate. Such an effect was small and not significant when considering 2008 as the placebo treatment year (columns 2 and 3).

To illustrate, an 81.5% increase in scrappage due to the scheme is quantified in about 482 thousand scrapped cars. As the scheme covered about 1 million cars, this means that slightly less than half (48%) of the cars scrapped under the scheme were would have not been scrapped in absence of the subsidy.

Back-of-the-envelop calculations suggest that the manufacturing of new cars in replacement to the additional scrapped cars purchased within the scheme contributed to as much as 2 million tons of CO2-equivalent greenhouse gas emissions.[2]

5. Conclusions

Our paper estimates and quantifies the impact of a car scrapping scheme introduced by the Italian government in 2009. Results suggest that the scheme was very effective in accelerating the scrappage of old cars. Placebo tests confirm that the effect of the scheme can be interpreted as causal. The environmental of reducing emissions of the car

[2] According to estimates based on the EXIOBASE 3 world input-output table, the global footprint of one euros' worth of final demand in Italy of the product "Motor vehicles, trailers and semi-trailers" released as much as 0.4278 kg of CO2-equivalent greenhouse gas emissions. Assuming an average price per car of about 10k euros, the manufacturing of each car accounts to 4.278 tons of CO2-equivalent emissions. Scaling-up this estimate to the 482k additional cars produced because of the scheme, total additional CO2-equivalent emissions amount to 2.062 million tons.

fleet, however, needs to be contrasted by an estimated increase of 2 million tons of CO2-equivalent greenhouse gas emissions released in the manufacturing phase.

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Figure 1: Log deregistrations by region and age (2008 - quadratic fit)

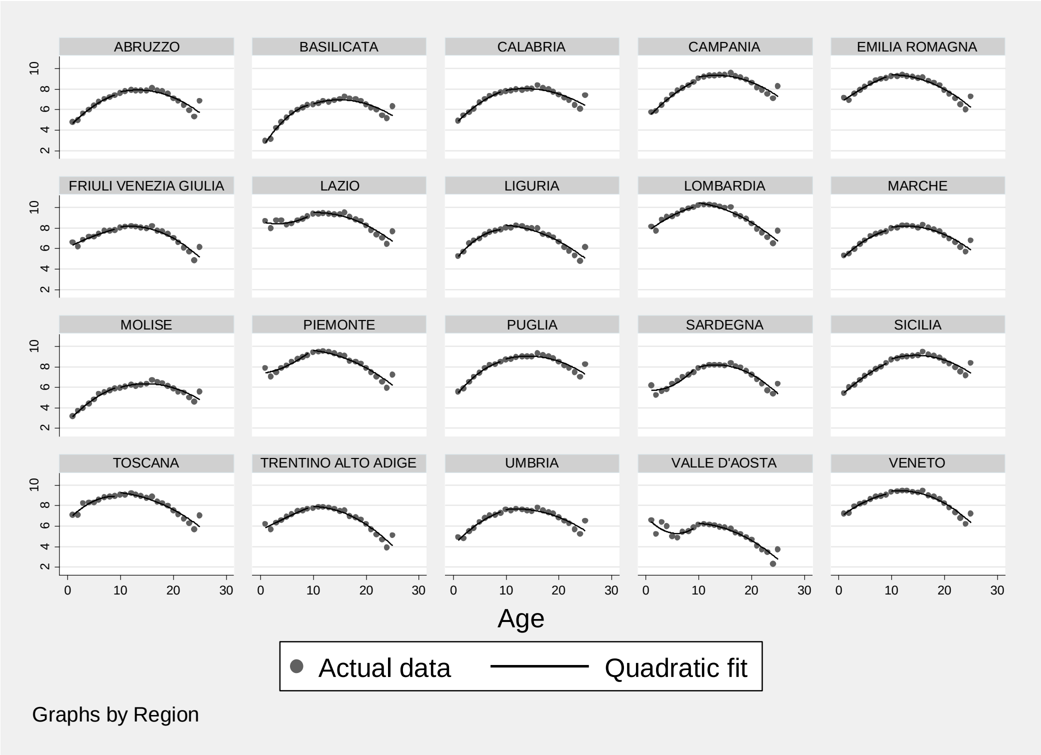

Figure 2: Log deregistrations by region and age (2009 - quadratic fit)

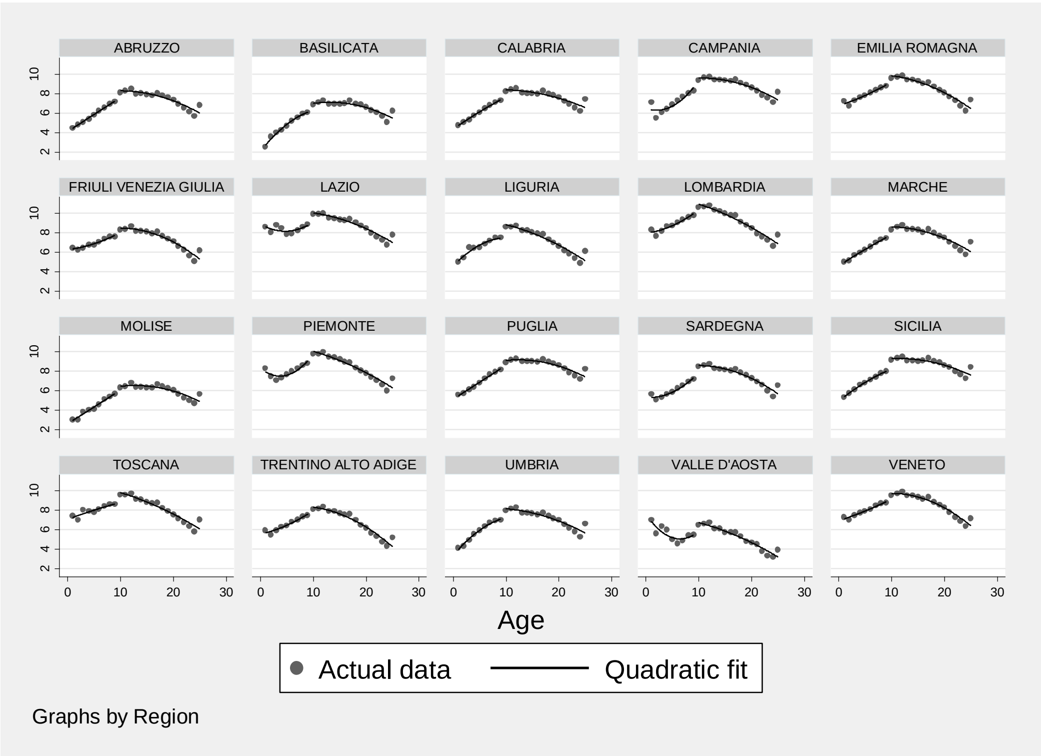

Table 1: Baseline results of the regression discontinuity design

RDD (quadratic)	2008	2009
Dummy age>=10	0.122	1.718***
	(0.534)	(0.458)
RDD (quadratic - region specific)	2008	2009
Dummy age>=10	0.336	1.887***
	(0.362)	(0.360)

N=500. Dependent variable: logarithm of deregistered cars by region and age. OLS model weighted by total deregistered cars by year and region. Standard errors clustered by region and age in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Quadratic fit (pooled or region-specific) is allowed to differ for cars with 9 or less years and cars with 10 or more years.

Figure 3: RDD (2008 vs 2009)

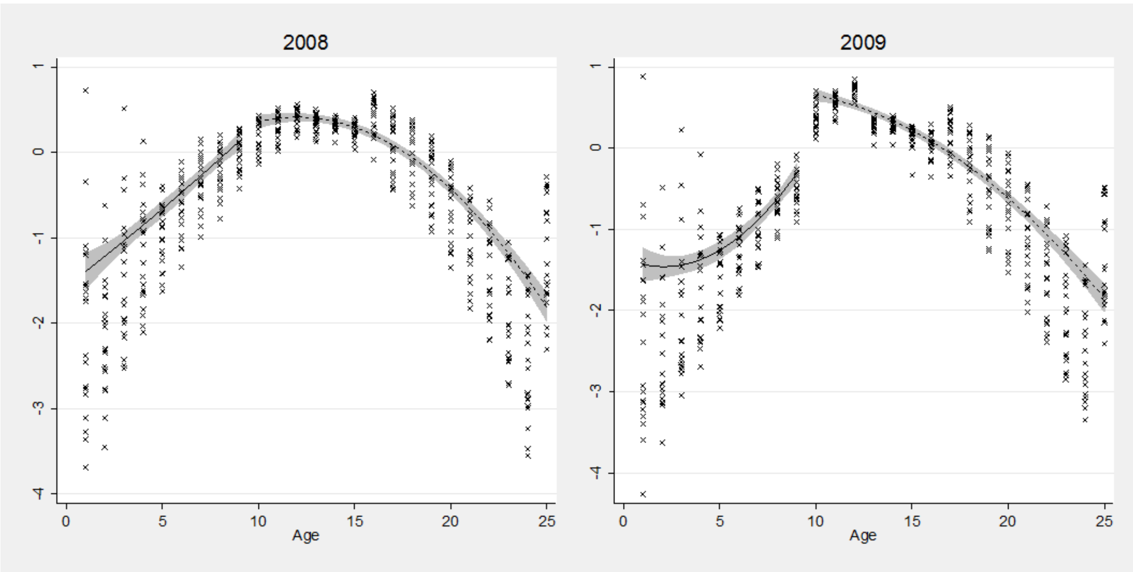

Table 2: Regression discontinuity design for different age thresholds

RDD (quadratic - region specific)	(1)	(2)	(3)
Dummy age>=8	-0.979*		
	(0.523)		
Dummy age>=9		0.171	
		(0.550)	
Dummy age>=10			1.887***
			(0.360)

N=500. Dependent variable: logarithm of deregistered cars by region and age for year 2009. OLS model weighted by total deregistered cars by year and region. Standard errors clustered by region and age in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Quadratic region-specific fit is allowed to differ for cars with 7, 8 and 9 or less years and cars with 8, 9 and 10 or more years in specification 1, 2 and 3 respectively.

Table 3: Difference-in-differences approach

Dep: log(deregistrations)	(1)	(2)	(3)
Age>=10 x Year=2009	0.586***		0.604***
(treatment)	(0.0339)		(0.0548)
Age>=10 x Year=2008		0.0178	0.0178
(placebo)		(0.0298)	(0.0298)
N	2500	2000	2500

Dependent variable: logarithm of deregistered cars by region and age for years 2005-2009. Fixed effect model (i=region,age) weighted by average deregistered cars by region-age. Standard errors clustered by region and age in parenthesis. * p<0.1, ** p<0.05, *** p<0.01. Year dummies, region specific time dummies and age specific linear trend included.